generally, but not always, more powerful than the deflection produced by thermo-contact.

XVII. The deflection caused by chemical action of a menstruum on two associated metals has no observable dependance on, or connexion with that produced by thermo-contact or attrition of these metals.

XVIII. The agent developed by the attrition of two metals, even when rapid, forcible, and long-continued, does not manifest any decomposing influence on chemical compounds, nor is it conducted by aqueous liquids, even when containing saline impregnations.

The President commented briefly upon Mr. Donovan's paper, noticing especially the labour and care which he had bestowed upon the investigation; at the same time he could not avoid regretting that the laws of the tribothermic phenomena had not been reduced to a smaller number, and to a simpler expression. The subject was one of very great interest and importance in a theoretical point of view; for it is in electrical phenomena of this class, if anywhere, that we may hope to gain an insight into the nature of the molecular agency upon which they are probably dependent, and thus to connect the science of electricity with other departments of physics.

The Rev. Samuel Haughton read a paper on the Laws of Propagation of Plane Waves in extended media.

In a paper read before the Academy, May 25, 1846, Mr. Haughton deduced the equations of solid and fluid bodies from the hypothesis that the molecular action is in the line joining the molecules, and that there is no action at right angles to that line. This hypothesis led to the conclusion that the function V, on which the internal forces depend, consists of six quantities;

$$\frac{d\xi}{dx}, \frac{d\eta}{dy}, \frac{d\zeta}{dz}, \frac{d\eta}{dz}+\frac{d\zeta}{dy}, \frac{d\zeta}{dx}+\frac{d\xi}{dz}, \frac{d\xi}{dy}+\frac{d\eta}{dx};$$

the discussion of the properties of this function occupies the remainder of the former paper. As the six quantities used in this function are not the same as the three quantities used by Professor Mac Cullagh in his researches in Physical Optics,

$$\frac{d\eta}{dz} - \frac{d\zeta}{dy}, \quad \frac{d\zeta}{dx} - \frac{d\xi}{dz}, \quad \frac{d\xi}{dy} - \frac{d\eta}{dx},$$

Mr. Haughton was led to suppose that the laws of the optical medium were quite distinct from those of solid and fluid bodies; and that, consequently, the molecular action in that medium is of a more general character, and is not confined to molecular forces acting in the line joining the molecules. In the present paper Mr. Haughton shows that this *primâ facie* view of the subject requires some restriction, and that Professor Mac Cullagh's equations, so far as they belong to the *propagation* of waves, may be deduced from the simple assumption of forces in the line joining the molecules; while the equations containing the laws of *reflexion and refraction* cannot be deduced from any such hypothesis. The object of Mr. Haughton's paper is, however, more general, and includes the discussion of the laws of propagation of plane waves in bodies of the most complicated molecular structure; from which are deduced the laws of bodies whose molecular action is more simple, and consists of simple attractions or repulsions between the molecules.

In an indefinitely extended body, no external forces acting, the most general function for the internal forces will be

$$V = F(a_1, a_2, a_3, \beta_1, \beta_2, \beta_3, \gamma_1, \gamma_2, \gamma_3);$$

where

$$a_1 = \frac{d\xi}{dx}, \quad a_2 = \frac{d\xi}{dy}, \quad a_3 = \frac{d\xi}{dz};$$

$$\beta_1 = \frac{d\eta}{dx}, \quad \beta_2 = \frac{d\eta}{dy}, \quad \beta_3 = \frac{d\eta}{dz};$$

$$\gamma_1 = \frac{d\zeta}{dx}, \quad \gamma_2 = \frac{d\zeta}{dy}, \quad \gamma_3 = \frac{d\zeta}{dz};$$

this function will be, in the case supposed, homogeneous, and of the second order, and will contain forty-five constants, if no hypothesis be made as to the nature of the molecular action. Mr. Haughton deduces from it the general laws of *propagation* of waves, and the particular conditions at the limits, which give the laws of *reflexion and refraction*. If any particular form be given to this function, the laws of propagation, reflexion, and refraction will be completely determined; but Mr. Haughton shows that this is not the case in the inverse problem, which proceeds from the laws of propagation of waves to the form of the function. In this case, different forms of the function, *i. e.* different conditions of molecular action, may produce the same laws of propagation. No such indeterminateness attends the laws of reflexion and refraction, and while several forms of the function may give the same laws of propagation, there is but one unique form of function for the laws of reflexion and refraction; these laws, therefore, give (so to speak) a more intimate and profound knowledge of the molecular structure of bodies, than the laws of propagation. If, therefore, two mechanical theories give the same laws of propagation for a given body, it is impossible to determine which is the right theory, without having recourse to the laws of reflexion and refraction; these will afford the true *experimentum crucis* for such a case, which has actually occurred in the optical theories of Mr. Green and Professor Mac Cullagh, and is discussed by Mr. Haughton in the memoir.

Mr. Haughton deduces the following, among other results, for the *propagation* of plane waves.

1. That M. Cauchy's construction, for determining the direction of molecular vibration, holds true for the most general law of molecular action. There will be three possible directions of vibration for the same direction of wave plane, and the equations will contain thirty-six arbitrary constants, which

will be the coefficients of the six ellipsoids used by Mr. Haughton in his former paper.

2. If the body be incapable of transmitting *normal pressures*, and the vibrations be normal and transversal, and the normal vibration vanish, the general character of the medium will be restricted, and the function V will become a function of the quantities

$$\frac{d\eta}{dz} - \frac{d\zeta}{dy}, \quad \frac{d\zeta}{dx} - \frac{d\xi}{dz}, \quad \frac{d\xi}{dy} - \frac{d\eta}{dx}.$$

This is the function used by Professor Mac Cullagh, and denotes a body which can propagate exclusively transverse vibrations. The equation contains six constants.

3. If the body be incapable of transmitting *tangential pressures*, and be restricted to propagate exclusively normal vibrations, the function V will be reduced to a function of the quantity

$$\omega = \frac{d\xi}{dx} + \frac{d\eta}{dy} + \frac{d\zeta}{dz}.$$

The equations contain one constant.

These are the equations commonly used in hydrodynamics, and may be shown to signify the perpendicularity of pressure to a given plane; they are approximately true in the equations of the motion of air.

4. If the body be only restricted to propagate normal and transverse vibrations, the function V will consist of three parts; the first denoting exclusively normal vibrations; the second, exclusively transverse vibrations; and the third, vibrations of a peculiar character. It is to be remarked that, if the original function V were a function of the six quantities used by Mr. Haughton in his former paper, this third portion of the function would disappear.

All bodies may be placed between two limits, one limit being bodies capable of propagating exclusively normal vi-

brations, such as air, gases, &c., approximately; and the other limit being a body, such as the optical medium, capable of propagating exclusively transverse vibrations. Bodies lying between these limits are capable of propagating both normal and transverse vibrations, or, more generally, three definite directions of vibration, neither normal nor transverse. The consideration of the properties of bodies with respect to the propagation of plane waves supplies a valuable means of classifying them, and may lead to more important results.

The remainder of Mr. Haughton's paper is occupied with some particular applications of the general method, which are not suited to the limits of an abstract.

Sir William Betham read a paper on the proceedings of a commission issued by Cromwell in 1653 or 1654, to inquire into the circumstances and conduct of certain Scotch settlers who were transplanted from Ulster to Kilkenny and Tipperary.

Sir Charles Coote was Governor of Derry for the Parliament in 1648, and on the execution of the King, the Scottish settlers in Ulster became indignant, raised several regiments, and besieged Derry.

In 1653 a commission was issued to Sir Charles Coote, and five or six others, to inquire into the conduct of the Scottish settlers, and arrange for their transplantation from Ulster to Kilkenny and Tipperary. Sir W. Betham's paper is a copy of the Commissioners' Report, with the terms of the transplanting, and the names of the persons transplanted.

The collection of Ogham stones, referred to at p. 235, was presented to the Academy by the Rev. Charles Graves, on the part of Mr. Hitchcock, who communicated the following account of their discovery in different localities in the barony of Corkaguiny, County Kerry.

No. 1 is from the churchyard of Aglish. Another very imperfect one remains in this churchyard.